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Technology Demonstration of Membrane Chemical Strippers for Removal of Lead-Based Paint on Plaster

Timothy Race and Ashok Kumar

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Construction Engineering Research Laboratory
PO Box 9005
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Final Report

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Washington, DC 20314-1000

Under Work Unit #CF-M B101

ABSTRACT:

Membrane chemical strippers for removal of lead based paint were researched. The technology demonstration of the membrane chemical stripper for removal of lead based paint on plaster and assessment was conducted at an abandoned house that is now classified as a historic building at Fort Riley, Kansas in October 2002.

Membrane chemical stripping was found to be generally effective at removing paint and reducing or eliminating the lead hazard. However, for plaster surfaces removal of residual paint and lead contamination must be accomplished by additional stripper applications or by HEPA sanding. Compared to other suitable methods of onsite paint removal such as low temperature heat gun paint removal, the membrane chemical stripping is relatively inexpensive. When compared with other lead paint management approaches such as enclosure, the method is expensive. The estimated cost range for membrane chemical stripping is $2.97/ft^2 to $4.74/ft^2.

Contents

List of Figures and Tables

Figures

Tables

Conversion Factors

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
acres	4,046.873	square meters
cubic feet	0.02831685	cubic meters
cubic inches	0.00001638706	cubic meters
degrees (angle)	0.01745329	radians
degrees Fahrenheit	(5/9) x (°F – 32)	degrees Celsius
degrees Fahrenheit	(5/9) x (°F – 32) + 273.15.	kelvins
feet	0.3048	meters
gallons (U.S. liquid)	0.003785412	cubic meters
horsepower (550 ft-lb force per second)	745.6999	watts
inches	0.0254	meters
kips per square foot	47.88026	kilopascals
kips per square inch	6.894757	megapascals
miles (U.S. statute)	1.609347	kilometers
pounds (force)	4.448222	newtons
pounds (force) per square inch	0.006894757	megapascals
pounds (mass)	0.4535924	kilograms
square feet	0.09290304	square meters
square miles	2,589,998	square meters
tons (force)	8,896.443	newtons
tons (2,000 pounds, mass)	907.1847	kilograms
yards	0.9144	meters

Preface

This technology demonstration was conducted for Headquarters, Department of the Army under Program Element (PE) 063728A, "Environmental Technology Demonstration Project 002, "Environmental Compliance Technology"; Work Unit CF-M B101, "Cost Effective Technologies to Reduce, Characterize, Dispose, and Reuse Sources of Lead Hazards." Bryan Nix, ACS (IM)-FDF, was the Technical Monitor.

The work was performed by the Materials and Structures Branch (CF-M) of the Facilities Division (CF) Construction Engineering Research Laboratory (CERL). The CERL Principal Investigator was Dr. Ashok Kumar. Part of this work was done by Corrosion Control Consultant and Laboratories (CCC&L), under Contract DACA42-02-P-0168. The Technical Editor was Gordon Cohen, Information Technology Laboratory. Martin J. Savoie is Chief, CEERD-CF-M and L. Michael Golish is Chief, CF. The Technical Director of the Installation Operations Business Area is Gary W. Schanche (CV-T), and the Director of CERL is Dr. Alan W. Moore.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Commander and Executive Director of ERDC is COL James R. Rowan, EN, and the Director of ERDC is Dr. James R. Houston.

1 Introduction

Background

The environmental problem being addressed is the removal of lead-based paint (LBP) from buildings. Deteriorated LBP poses a serious health risk to building occupants particularly children. Paint removal eliminates the health risk associated with LBP. Paint removal methods are generally reserved for limited areas and for surfaces where historic preservation requirements may apply. Paint removal techniques demand high levels of control and worker protection, and also generate significant amounts of hazardous waste. The expected benefit of this technology is the cost-effective removal of LBP on building surfaces. Competing technologies such as low temperature heat guns, HEPA sanding, and wet scraping have greater potential for creating hazardous lead fume or dust. Solvent-containing chemical paint strippers may emit toxic vapors and may be flammable. Methylene chloride containing paint strippers are expressly forbidden by Army guidance. Other lead hazard control methods such as management in place using wall coverings may not be architecturally appropriate or cost effective in all cases. Membrane chemical strippers are paste-like products that are hand applied to the substrate and covered with a membrane material to keep the product wet during a prolonged dwell period. The strippers contain caustic and work by alkaline hydrolysis of the paint resin. The demonstration was performed on interior plaster wall surfaces with many layers of old paint.

Objective

The objective of this technology demonstration was to evaluate the cost and performance of membrane chemical paint strippers. The performance objective was the complete removal of the lead hazard in a single application of the membrane chemical stripper. Complete removal is defined as visually free of residual paint and maximum residual lead of 1 mg/cm^2. The performance objectives were only partially met.

Approach

Membrane chemical strippers for removal of lead based paint were researched. The technology demonstration of the membrane chemical stripper for removal of lead based paint on plaster and assessment was conducted at an abandoned house that is now classified as a historic building at Ft. Riley, Kansas in October 2002.

Regulatory Drivers

The primary regulatory driver is Section 1017 of the Residential Lead-Based Paint Hazard Reduction Act of 1992, which is often referred to as Title X ("Title Ten") because it was enacted as Title X of the Housing and Community Development Act of 1992 (Public Law 102–550).

Mode of Technology Transfer

Technology transfer is being accomplished by: (1) Technology Transfer Implementation Plan through the U. S. Army Environmental Center (AEC); (2) PWTB 420-70-2 "Installation Lead Hazard Management;" (3) participation in User Groups and Committees, such as the Army Lead and Asbestos Hazard Management Team, Federal Lead Based Paint Committee Meetings at EPA or HUD, and ASTM Committee E06.23 document titled *Standard practice for the Selection of Lead Hazard Reduction Methods for Identified Risks in Residential Housing or Child Occupied Facilities*; (4) websites maintained by the Assistant Chief of Staff for Installation Management (ACSIM). http://www.hqda.army.mil/csimweb/fd/policy/facengcur.htm], AEC [http://aec.army.mil/usaec/], and the U. S. Army Engineer Research and Development Center Construction Engineering Research Laboratory (ERDC/CERL) [http://www.cecer.army.mil], as well as the Hands-on-Skills Training (HOST) website at [http://www.hqda.army.mil/ csimweb/fd/policy/host/index.htm]; (5) demonstration /validation of emerging technologies through Army demonstration funding (6.3) starting in fiscal year 2000 (FY00) and continuing through FY03, and cost/performance reports from those demonstrations, including a Decision Tree for Selection of Optimal LBP Hazard Management and Removal for Buildings.

2 Technology Description

Technology Development and Application

The intended use of membrane chemical paint strippers as evaluated herein is the removal of paint from interior architectural surfaces including plaster and drywall. The technology is applicable to the removal of all types of architectural coatings. The target contaminants are lead compounds used in architectural coatings as hiding and coloring pigments and as agents to promote drying of certain types of coatings. Membrane chemical strippers are thick paste-like materials containing caustic, water, and inert ingredients. A membrane or cover material is used to keep the stripper wet as it works. The stripper works by alkaline hydrolysis of the paint wherein the resin is attacked and loosened from the substrate.

Process Description

Chemical stripper paste is trowel applied with a notched applicator and then smoothed to achieve a uniform total material thickness of 1/8- to 1/4-inch (Figure 1). The membrane is then adhered to the wet stripper and smoothed down to ensure contact (Figure 2). After a dwell time of 12- to 24-hours the membrane and stripper are removed along with the loosened paint (Figure 3). The stripped surface in then scraped with a suitable blade to remove any remaining stripper and paint. The caustic residue on the surface is then neutralized using a spray-applied dilute solution of acetic acid in accordance with the manufacturer's dilution instructions (Figure 4). Neutralization is allowed to occur over a 2- to 6-hour period. Following neutralization the surface is washed with potable water and the surface is tested for residual alkalinity using moistened pH paper. The dried surface is then repaired as necessary. For plaster surfaces this may include patching deteriorated plaster and cracks with suitable repair materials. After substrate repair the surface is then ready for priming and topcoating (Figure 5).

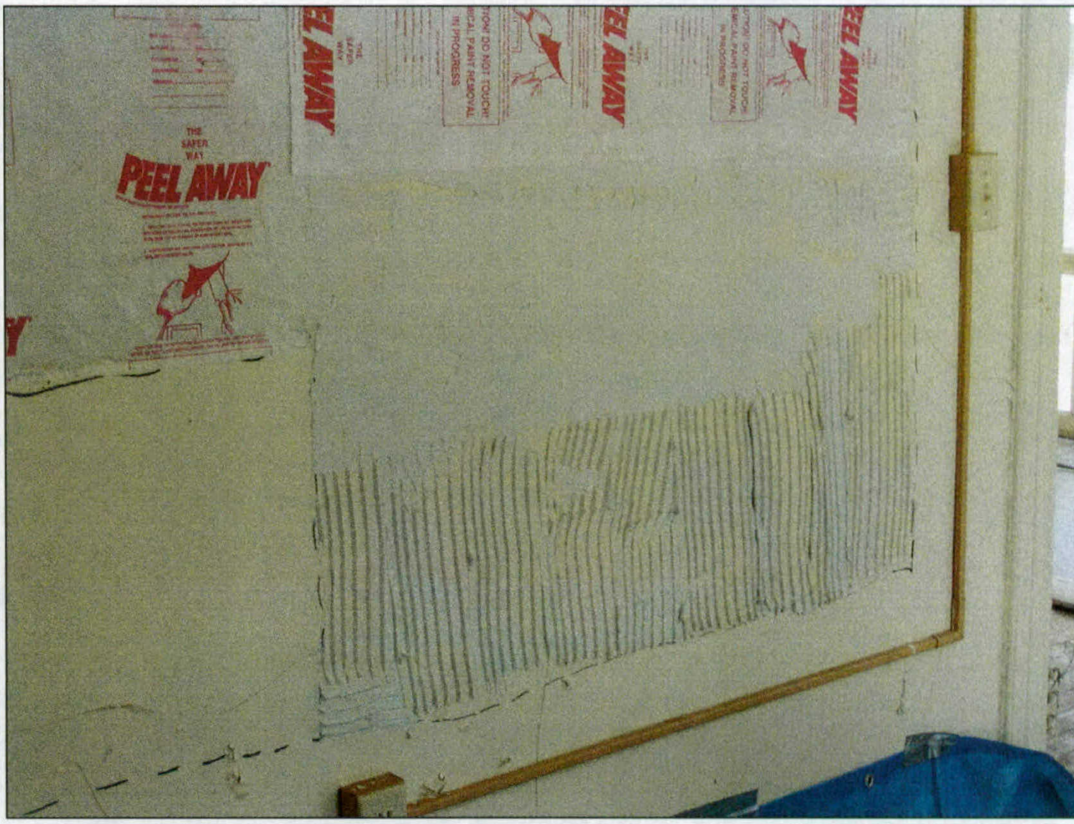

Figure 1. Trowel applied chemical stripper paste.

Figure 2. Membrane cover over stripper paste to retain moisture.

Figure 3. Peeling off membrane and loosened paint.

Figure 4. Acid neutralization of the surface after paint removal.

Figure 5. Repainting the stripped area.

UFGS-13281A Lead Hazard Control Activities provides details on health, safety, and environmental requirements for lead hazard control activities. The primary requirements are accident prevention planning, medical surveillance, respiratory protection, training, sampling and analysis, clearance testing, personal protective equipment, hygiene facilities, posted warnings and notices, work procedures, and hazardous waste.

Membrane chemical strippers are easy to use and require little training beyond following the manufacturer's instructions.

Previous Testing of the Technology

Membrane chemical strippers have been used on numerous lead paint removal projects for HUD, Capitol Buildings, military installations, and other restoration projects. The Navy evaluated a membrane chemical stripper similar to that evaluated herein as early as 1984.

Advantages and Limitations of the Technology

The general advantages of membrane chemical strippers include: minimal capital expenditure, minimal lead aerosol creation, no toxic solvent emissions, and noise reduction. The limitations of this technology include reduced effectiveness at lower ambient temperatures and increased hazardous waste production.

3 Demonstration Design

Performance Objectives

The primary performance objectives are listed in Table 3-1.

Table 1. Table 3-1: Performance objectives.

Type of Performance Objective	Primary Performance Criterion	Expected Performance (Metric)	Actual Performance Objective Met?
Quantitative	Lead hazard removal	< 1 mg/cm^2 lead remaining	Partially met
Qualitative	Paint removal	Zero residual paint	Not met

Selection of Test Site/Facility

Test site selection was based on the availability of a lead painted interior architectural surface with lead content greater than 5 mg/cm^2.

3.3 Test Facility History/Characteristics

The test location was Ft. Riley, Kansas. The building (166A) where the demonstration was performed is an historic housing duplex constructed in 1893 (Figure 6). Tests were performed on interior plaster veneer wall surfaces of the kitchen and living room. Building 166A has not been occupied since 1985.

3.4 Physical Set-up and Operation

The cost and performance evaluation of chemical membrane paint stripper was performed during the week of August 26, 2002.

Figure 6. Building 166A/B at Ft. Riley, KS.

3.5 Sampling/Monitoring Procedures

Paint chips were analyzed using a micrometer to determine total dry film coating thickness in the test areas and to estimate the number of layers of paint. Pre- and post-work lead analyses (portable XRF spectrophotometer) were performed to determine lead content in units of mg/cm^2 (Figure 7). Neutralization of the caustic stripper was verified using pH paper. Solid and liquid waste streams were analyzed for total and TCLP lead and were weighed.

Figure 7. XRF testing for residual lead on stripped plaster wall.

3.6 Analytical Procedures

Paint chip and solid waste samples were prepared for total lead analysis in accordance with EPA 600/R-93/200M-P (Total Metals in Paint Chips, Sonication) and analyzed in accordance with EPA 6010B (ICP-AES Method for Determination of Metals).

The liquid waste sample was prepared for total lead analysis in accordance with EPA 200.2 – M (Metals in Waste Water) and analyzed in accordance with EPA 200.7 (ICP-AES Method for Trace Element Analysis of Water and Wastes).

Solid and liquid wastes were prepared for characterization in accordance with EPA 1311 (TCLP for Metals) and analyzed in accordance with EPA 6010B (ICP-AES Method for Determination of Metals).

4 Performance Assessment

Performance Data

The performance data is summarized in Table 4-1.

Table 2. Table 4-1: Performance data.

Lead Content of Surfaces Measured by XRF (mg/cm^2) Average ± 1 STD					
Kitchen			Living Room		
Initial	Stripped Clean	Stripped with Residue[1]	Initial	Stripped Clean	Stripped with Residue[2]
5.1 ± 0.35	0.4 ± 0.3	5.45 ± 0.6	6.5 ± 0.55	0.4 ± 0.4	6.5 ± 2.5

[1]Stripped area with residue was 3% of total area of kitchen.

[2]Stripped area with residue was 20% of total area of living room.

Performance Criteria

The primary performance criteria are listed in Table 4-2. Performance was assessed visually (residual paint) and quantitatively (residual lead) using a portable XRF instrument measuring in units of mg/cm^2. Determinations were made for two test areas, the kitchen and living room. Lead values are reported as averages plus or minus one standard deviation. Areas stripped clean and areas with residual paint are treated separately. Total areas of residual paint were estimated visually. Estimated final residual lead contents for the kitchen and living room were estimated from areas with and without residual paint using the average lead contents.

(Area % Clean x [Pb] Clean) + (Area % Residue x [Pb] Residue) = Residual Lead

In addition to performance testing existing paint and wastes streams were sampled and analyzed. Table 4-3 reports the results of these analyses.

Table 3. Table 4-2: Performance criteria.

Type of Performance Criterion	Primary Performance Criterion	Performance Criterion: Residual Lead	Actual Performance: Residual Lead
Quantitative	Lead hazard removal	< 1 mg/cm^2 lead remaining	Kitchen: 0.55 mg/cm^2 Living Room: 1.6 mg/cm^2
Qualitative	Paint removal	Zero residual paint	3% residual paint - kitchen 20% residual paint - living room

Table 4. Table 4-3: Sample analyses.

Sample	Description	Quantity	Total Lead	TCLP Lead	pH
Kitchen Paint	paint chips, 6 layers totaling 0.030 inches	NA	37,000 ppm	NA	NA
Living Room Paint	paint chips; 6 layers totaling 0.030 inches	NA	48,000 ppm	NA	NA
Liquid Waste	wash water	60 pounds	210 ppm	31 ppm	12.0
Solid Waste	stripper, membrane, and paint residue	60 pounds	1100 ppm	0.39 ppm	12.5

Kitchen and living room walls have significant lead levels as measured in the field by the portable XRF spectrophotometer and in the laboratory by inductively coupled plasma – atomic emission spectroscopy. The wash water (liquid waste) exhibited the hazardous characteristic with TCLP Pb greater than 5.0 ppm. The solid waste (combined stripper residue, membrane, and paint residue) did not exhibit the hazardous characteristic for lead. However, the solid waste was corrosive with pH greater than 12 and therefore is hazardous.

Data Assessment

The performance goals were only partially met. For the kitchen wall the stripper reduced lead to less than the required 1 mg/cm^2 and for the living room wall it did not. Residual paint covered 3% of the kitchen wall and 20% of the living room wall. The performance differences between the kitchen and living room are at least partly attributable to differences in the paint as well as visual contrast differences. Although the paint film thickness was the same in the living room and kitchen, the living room paint had a higher lead concentration and the walls had a higher unit area lead content. Residual paint was difficult to visually identify on the living room walls during the scraping process because of the similarity in color between the paint and the substrate. Patchy areas of residual paint were more evident on close examination of the surface after it had dried.

Consequently the scraping process on the living room wall was not as effective at removing residual paint and lead. In practice a contractor would either reapply stripper until the performance goal was met or would perform touchup paint removal by HEPA sanding.

The stripper manufacturer claims their product is effective on up to 30 layers of accumulated paint. This is roughly equivalent to a film thickness of 0.075 inches. The paint stripped for the demonstration was within the manufacturer's claims in terms of number of layers (six) and thickness (0.030 inches). The paint stripper was generally effective at removing the accumulated paint. However, on both of the test walls there were both residual paint and lead.

Technology Comparison

UFGS-13281A Lead Hazard Control Activities identifies seven paint removal methods. Of these seven methods three are not applicable to interior wall surfaces such as plaster and drywall. HEPA vacuum blasting and HEPA needle guns are vigorous mechanical methods that will damage relatively weak substrates such as plaster and drywall. Another method, offsite paint removal, is impractical for items that are a permanent part of the structure such as walls. The remaining competing technologies include solvent-based chemical strippers, low temperature heat gun, HEPA sanding, and wet scraping. HEPA sanding is impractical for removing built up layers of coating and also performs poorly on thermoplastic-type coatings such as latex coatings commonly used on most architectural surfaces today. Sanding results in melting of the latex coating and subsequent rapid degradation of the sanding media. Wet scraping is very limited in its ability to remove adherent coatings and is generally only used to remove loose coatings. Low temperature heat gun and chemical paint strippers are typically the only methods of paint removal used for architectural surfaces such as interior plaster and drywall. They remove paint down to the substrate. However, HUD cautions that heat guns may cause damage to drywall and plaster surfaces. Both methods are generally effective on all types of coatings and can remove most thicknesses of coating. Membrane chemical strippers of the caustic type are generally preferred over organic solvent-type strippers for interior work because they do not emit toxic fumes and are not flammable.

5 Cost Performance Assessment

5.1 Cost Reporting

Unit area costs were estimated based on the costs of the demonstration. Cost data is reported in Table 5-1. Cost assumptions include a fully burdened labor rate of $30/hour and hazardous waste disposal costs of $316/ton. Material costs are those stated.

Table 5. Table 5-1: Unit area cost (UAC) for membrane chemical removal.

	Labor		Consumable Materials		Total
Work Phase	Description	UAC ($/ft^2)	Description	UAC ($/ft^2)	UAC ($/ft^2)
Mobilization	Protect surfaces and stage equipment	0.275	Polyethylene sheeting	0.015	0.290
Application	Trowel on stripper and apply membrane	0.575	Peel Away 1 at 25 ft^2/gal and $25/gal	1.000	1.575
Removal	Peel off membrane and scrape surface	0.350	None		0.350
Neutralization	Spray apply acid neutralizer with garden sprayer	0.165	Peel Away Neutralizer diluted 5 to 1 and applied at 1.5 liters per 100 ft^2. Neutralizer $19/gal	0.015	0.180
Cleaning	Water wash wall surfaces	0.200	None		0.200
Demobilization	Remove all equipment and clean contaminated surfaces as necessary	0.075	None		0.075
Clearance	XRF and wipe testing	0.188	Lab cost for one wipe test per 500 ft^2 at $6/test	0.012	0.200
Waste	Waste handling	0.075	Hazardous waste disposal for 0.6 pounds liquid waste and 0.6 pounds solid waste per square foot.	0.190	0.265
Total Cost $3.14/ft^t					

5.2 Cost Analysis

A cost analysis was performed to assess cost uncertainty and performance variability. The major variable cost drivers are stripper material cost and hazardous waste disposal.

The waste volume and characteristic are variable depending on stripper consumption and lead content of the paint. Waste volume may reasonably vary by plus/minus 50% or $\pm$ \$0.095/ft^2. Wastes generated from paints with lower lead content may not exhibit the hazardous characteristic for lead. This could eliminate up to 90% of the waste disposal cost, or \$0.17/ft^2.

Dumond Chemical recommends a spreading rate of 10- to 15 ft^2/gal. The cost assessment uses a spreading rate 25 ft^2/gal based on the demonstration data. Material costs could be as much as \$1.50/ft^2 higher with reduced spreading rates.

Reduced performance could necessitate a second application of the stripper. This would generally be a contractor variable provided the specification did not call for a single application of the stripper.

Summing the cost variables and estimated cost in 5.1 the projected cost range is estimated at \$2.97/ft^2 to \$4.74/ft^2.

Cost Comparison

Low temperature heat guns and membrane chemical strippers are generally the most acceptable methods for the in place removal of LBP from interior surfaces including plaster, drywall, and wood. Previous research measured the productivity of heat guns at 1.00- to 5.88-ft^2/hour. Table 5-2 illustrates the estimated cost of heat gun paint removal using similar assumptions as those used for the Ft. Riley demonstration of membrane chemical strippers.

Low temperature heat gun removal is generally more expensive than membrane chemical stripping. The cost range for low temperature heat gun removal is \$5.97/ft^2 to 30.87/ft^2. The cost range for membrane chemical stripper removal is \$2.97/ft^2 to \$4.74/ft^2. The median cost of low temperature heat gun removal (\$18.42/ft^2) is more than four times higher than the median cost of membrane chemical stripper removal (\$3.96/ft^2).

Table 6. Table 5-2: Unit area cost (UAC) for low temperature heat gun removal.

	Labor		Consumable Materials		Total
Work Phase	Description	UAC ($/ft^2)	Description	UAC ($/ft^2)	UAC ($/ft^2)
Mobilization	Protect surfaces and stage equipment	0.275	Polyethylene sheeting	0.015	0.290
Heat Gunning	Heat paint and scrape	5.10 - 30.00	None		5.10 – 30.00
Cleaning	Water wash wall surfaces	0.200	None		0.200
Demobilization	Remove all equipment and clean contaminated surfaces as necessary	0.075	None		0.075
Clearance	XRF and wipe testing	0.188	Lab cost for one wipe test per 500 ft^2 at $6/test	0.012	0.200
Waste	Waste handling	0.075	Hazardous waste disposal for 4.32 in^3 waste per ft^2 based on a 0.030 inch coating thickness	0.035	0.110
Total Cost $5.97 – 30.87/ft^2					

6 Implementation Issues

Cost Observations

The major cost drivers are stripper material and hazardous waste disposal. Cost reduction potential is minimal. However, one chemical stripper supplier (Back to Nature by Dynacraft) produces a product (Strip-Tox) incorporating a stabilizing additive (Pre-Tox 2000) known to eliminate the hazardous characteristic for lead. This product could eliminate up to 90% of the waste disposal cost, or $0.17/ft^2. Government procurement of the paint stripper could also eliminate approximately 20% of the stripper material cost because contractors typically will pass through an additional cost on all materials and supplies. Government supply could reduce material costs equivalent to $0.20/ft^2.

Performance Observations

The performance goals were only partially met. On one wall surface the stripper reduced lead to less than the required 1 mg/cm^2 and another wall it did not. The performance differences are at least partly attributable to differences in the paint as well as visual contrast differences. The surface which did not meet the performance goal had residual paint which closely matched the substrate color and was difficult to see. Consequently the scraping process was not as effective at removing residual paint. In practice a contractor would either reapply stripper until the performance goal was met or would do touchup by HEPA sanding.

Scale-up

No scale-up issues were identified during the performance of the demonstration and none should be expected.

Other Significant Observations

The necessary worker skill level is low to moderate. Worker training and expertise in work-safe lead practices is more salient and complex than the paint removal process itself.

Removing residual coating by scraping will gouge relatively soft substrates such as drywall and plaster resulting in a poor appearance. Significant amounts of patching and repair are necessary to improve the final appearance of surfaces prepared by chemical membrane paint removal. This additional cost is not reflected in the demonstration cost analysis, but would be an additional cost during repainting. The contract documents should address the level of post-paint removal repair that is required.

The quantity of hazardous waste produced by the process is significant. Hazardous waste disposal cost should be a separate line item in the cost proposal to ensure that potential contractors have planned adequately for the cost of waste disposal.

Because the cost of onsite paint removal is so high the first choice of lead hazard control for interior wall surfaces should always be enclosure. Onsite paint removal should be reserved for small areas or for historic preservation.

Performance specifications are recommended over prescriptive-type specifications for paint removal. Performance requirements will allow maximum flexibility to the contractor to combine methods of removal and to seek the most cost-effective method or methods for a particular job. The general performance criteria should be to produce a lead-free substrate and work area. Lead-free clearance criteria exist for various work area surfaces such as floors and window sills and troughs. Stripped walls and ceilings should be considered lead-free when they are visually free of residual paint and there is less than 1 mg/cm^2 lead as measured by XRF. Visual inspection must be performed prior to repainting. It should be noted that HUD recommends only a visual criterion and does not recommend that XRF testing be used to accept the stripped surfaces. Because membrane chemical strippers may leave hotspots where some paint is left imbedded in the surface an appropriate statistical method must be employed to evaluate the overall lead content of stripped surfaces when using the XRF as an additional criterion. It is not practical to require 100% of the surface to meet the 1 mg/cm^2 lead criterion.

Lessons Learned

Membrane chemical stripping will not remove 100% of the paint in a single application as judged using either visual or XRF lead concentration criteria. Additional surface preparation such as HEPA sanding is necessary to remove residual paint and lead. Scraping wall surfaces will result in gouges that must be repaired prior to repainting.

Approach to Regulatory Compliance and Acceptance

The primary regulatory driver is the Residential Lead-Based Paint Hazard Reduction Act of 1992, which is often referred to as Title X ("Title Ten") because it was enacted as Title X of the Housing and Community Development Act of 1992 (Public Law 102–550). Onsite lead paint removal is one means of achieving compliance.

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Acronyms Used

ASTM	American Society for Testing and Materials
EPA	U.S. Environmental Protection Agency
HEPA	High Efficiency Particulate Air
HUD	U.S. Department of Housing and Urban Development
ICP-AES	Inductively Coupled Plasma – Atomic Emission Spectroscopy
LBP	Lead-Based Paint
STD	Standard Deviation
TCLP	Toxic Characteristic Leaching Procedure
UAC	Unit Area Cost
UFGS	Unified Facilities Guide Specification
XRF	X-Ray Fluorescence

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14. ABSTRACT
Membrane chemical strippers for removal of lead based paint were researched. The technology demonstration of the membrane chemical stripper for removal of lead based paint on plaster and assessment was conducted at an abandoned house that is now classified as a historic building at Ft. Riley, Kansas in October 2002.

Membrane chemical stripping was found to be generally effective at removing paint and reducing or eliminating the lead hazard. However, for plaster surfaces removal of residual paint and lead contamination must be accomplished by additional stripper applications or by HEPA sanding. Compared to other suitable methods of onsite paint removal such as low temperature heat gun paint removal, the membrane chemical stripping is relatively inexpensive. When compared with other lead paint management approaches such as enclosure, the method is expensive. The estimated cost range for membrane chemical stripping is \$2.97/ft2 to \$4.74/ft2.

15. SUBJECT TERMS
Lead-based paint, paint removal, hazardous wastes, paint stripper, plaster walls, alkaline hydrolosis

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Timothy Race
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